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Combination of the searches for the low-mass Standard Model Higgs boson with ATLAS detector

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Summary. — In this paper, a brief overview of the results, based on proton-proton collision data recorded at a centre-of-mass energy of 7 TeV in 2011 and 8 TeV in 2012, for the properties of a new Higgs-like particle at 125.5 GeV are presented.

PACS 14.80.Bn – Standard-model Higgs bosons.

1. – Mass and signal strength

The mass of the newly discovered boson can be measured precisely in the high mass resolution channels $H \to \gamma\gamma$ and $H \to ZZ^{(*)} \to 4l$. Figure 1 (left) shows the profile likelihood ratio as a function of m_H for $H \to \gamma\gamma$ and $H \to ZZ^{(*)} \to 4l$ channels and their combination. The combined mass is measured to be $m_H = 125.5 \pm 0.2(stat)^{+0.5}{}_{-0.6}(sys)$ GeV [1]. The best-fit signal strength parameter (μ) is a convenient observable to test the com- patibility of the data with the background-only hypothesis ($\mu = 0$) and the SM Higgs hypothesis ($\mu = 1$). The best-fit of the μ for each channel independently and for the combination are in fig. 1 (right) for a mass of $m_H = 125.5$ GeV, the measured global signal yield is $\hat{\mu} = 1.30 \pm 0.13(stat) \pm 0.14(sys)$, ref. [1].

2. – Couplings

The signal strength scale factors $\mu_{i,f}$ for either the Higgs production or decay modes were determined. However, for a consistent measurement of Higgs boson couplings, production and decay modes cannot be treated independently. The framework and benchmarks as recommended in ref. [2], measurements of coupling scale factors are implemented using a LO tree level motivated framework, ref. [3].

Fermion versus vector (gauge) couplings. – This benchmark is an extension of the single parameter fit, where different strengths for the fermion and vector couplings are probed. It assumes that only SM particles contribute to the $H \to \gamma\gamma$ and $gg \to H$ vertex loops, but any modification of the coupling strength factors for fermions and vector bosons are propagated through the loop calculations. In fig. 2 there is a plot with the best-fit of κ_V and κ_F with 68% CL contours.

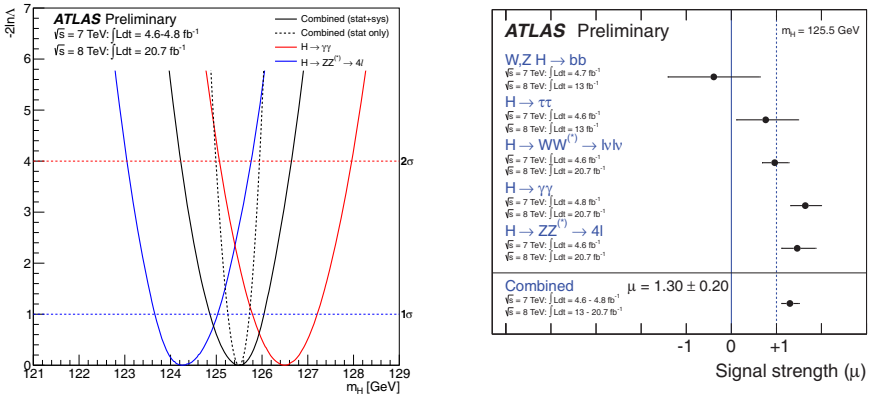

Fig. 1. – Left: the profile likelihood ratio $-2ln\Lambda(m_H)$ as a function of m_H for the $H \to \gamma\gamma$ and $H \to ZZ^{(*)} \to 4l$ channels and their combination, obtained by allowing the signal strengths $\mu_{\gamma\gamma}$ and μ_{4l} to vary independently. Right: summary of the best-fit values and uncertainties for the signal strength for the individual channels and their combination at a Higgs boson mass of 125.5 GeV.

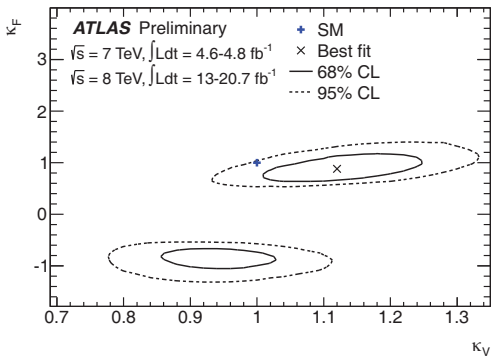

Fig. 2. – Correlation of the coupling scale factors κ_F and κ_V with 68% CL contours.

3. – Conclusions

Using data taken in 2011 and 2012, at centre-of-mass energies of respectively 7 TeV and 8 TeV, the ATLAS collaboration has reported the observation of a new particle with a mass of $m_H = 125.5$ GeV, in the search for the Standard Model Higgs boson. Within the current statistical uncertainties and assumptions, no significant deviations from the Standard Model couplings are observed.

REFERENCES

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[3] ATLAS Collaboration, *Combined coupling measurements of the Higgs-like boson with the ATLAS detector using up to* 25 fb^{-1} *of proton-proton collision data*, ATLAS-CONF-2013-034.